QUARTERLY PROGRESS REPORT
DRD 875MA-003
January 2006 – March 2006

Marshall Space Flight Center
Safety and Mission Assurance Mission Services Contract
NAS8-00179

Approved:

Original signed by:

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MSFC S&MA Mission Services

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1.0 INTRODUCTION

Hernandez Engineering, Inc. (HEI) successfully performed all required activities and tasks, as described in this report, in fulfillment of their Safety and Mission Assurance (S&MA) Mission Services Contract (NAS8-00179) with NASA's Marshall Space Flight Center (MSFC). This report covers a three-month period of the contract's second quarter of the extension year: January through March 2006.

2.0 GENERAL MANAGEMENT

2.1 Data Requirements

The second quarter of the extension year of the S&MA Mission Services contract was successfully completed on March 26, 2006. All Data Requirements (DR) Documents were submitted on or ahead of schedule throughout the quarter. They included DRD 875CD-001 On-Site Employee Location Listing; DRD 875MA-002 Financial Management Reports; DRD 875MA-003 Progress Reports (Monthly/ Quarterly); DRD 875MA-006 Operations Plan, Problem Assessment Center (PAC); DRD 875MA-007 Quarterly Open Problems List; DRD 875MA-008 Monthly Newly Opened/Closed Problem Summary; DRD 875SA-002 Mishap and Safety Statistics Reports; and Quarterly Safety Performance Evaluation.

2.2 Personnel Status

(b)(4) [redacted]

3.0 Business Management

We have experienced no financial or business management problems during this period. We attribute this to close attention to details, effective use of established controls designed to efficiently respond to program changes---both anticipated and unexpected---and the continuing support of our corporate financial group's dedicated efforts at controlling overhead expenses.

See the March 2006 Monthly Financial Report, DRD 875MA-002, for specifics. Attachment 2, Man-Hours Expended, of this report contains a description, by major task, of the total man-hours expended this period. (b)(4) [redacted]

(b)(4) [redacted]

4.0 PERFORMANCE OF WORK AND USE OF FACILITIES AND EQUIPMENT

4.1 Safety

4.1.1 Industrial Safety (IS)

The Industrial Safety (IS) received approval from Industrial Safety Department (ISD) for its schedule of annual inspections for CY06 and inspections began accordingly. In the first quarter of CY06, IS performed 145 OSHA annual facilities compliance inspections and provided all

required reports in a timely manner. IS conducted 68 construction site compliance inspections to monitor adherence to OSHA and MSFC safety standards. All identified safety discrepancies were reported and documented in the SHEtrak database to support MSFC's compliance with OSHA, NASA, and other consensus code requirements.

Among other activities, IS also: (1) participated in two final safety inspections of facilities under renovation or construction; (2) reviewed 57 sets of facility design drawings for compliance with OSHA and consensus codes; (3) taught one training class to supervisors on how to perform monthly workplace safety visit inspections; and, (4) at the specific request of our customer, HEI

(b)(4) [redacted]

In support of a the contract extension year SOW (formerly the S&MA Technical Directive Number 0131), IS continued to provide additional administrative and technical support to the MSFC SHE Committee including: (1) assistance to the SHE Committee Chairperson and ISD by supporting monthly SHE Committee meetings, which included collection and organization of pre-meeting briefing charts, serving as meeting recorder and preparation of draft meeting minutes; (2) IS also supported the SHE Committee by entering SHE Committee action items into CAITS. Also, in support of ISD and the HEI IM team, IS continued to address this contract year's Area of Emphasis (AOE) to evaluate the new RiskSafe™ software in support of the Hazard Assessment Process.

IS initiated, completed or followed-up on 57 safety assessments (SA) and associated hazardous operations reviews. Examples include: (1) continued final support of safety assessment for the ET Substrate Strain Panel Test, Building 4619; (2) continued support of the Hazard Analyses for Furnaces in Building 4481 including the High Temperature Furnace for Ilmenite Processing; (3) supported QD50 in an operation being performed in the high bay of the Helium Chamber Operations Building 4705; (4) continued to assist in the development and analysis of the safety assessment and related assistance in support of the activation and operations of the Hot Fire Test Trailer (HoFiTT), renamed Spacecraft Propulsion Test Capability (SPTC) in building 4656; (5) performing the safety assessment for the two Helium Ballistic Guns located in the modified shipping container near the Impact Facility Building 4571; (6) completed the draft safety assessment for the Hydrometeor Impact Gun (HIG) in Building 4571 of the Impact Test Facility; (7) assisted ET30 with the safety assessment review and other recommendations made by the Incident/Mishap Investigation Team for the Rome Chamber Incident Investigations in Building 4612; (8) completed draft safety analysis for the SSME ASI testing in Test Cell 103 using Gaseous Hydrogen and Gaseous Oxygen while the ASI is fired at building 4; and; (9) completed the safety assessment for the initial Booster Separation Motor (BSM) Proposed Testing at Test Stand 116.

IS continued to support the implementation of the NASA lifting standard, NASA-STD-8719.9 by providing day-to-day advice and assistance to S&MA customers. IS advised civil service and contractor managers, supervisors and employees on requirements for lifting equipment usage in support of the MSFC SHE Program. Also, IS continued to be an active participant in the Lifting Device Equipment (LDE) SHE Subcommittee. In support of the task to administer proficiency

exams to civil service and contractor operators of overhead cranes, fork lifts, small truck mounted hoists, and aerial lifts, IS administered hands-on proficiency examinations to 5 aerial lift, 22 overhead crane, and 3 forklift operators in support of the MSFC Personnel Certification Program, MWI 3410.1. Additional ISE lifting assistance was provided to various Center projects to include; (1) lift of the Program Critical Hardware (PCH) ECLSS Rack OGA #3, (2) lift of the International Space Station (ISS) Habitation Module using the Super Guppy Shipping Fixture, (3) support for the Lifting Tool (Hoist) acquisition in building 4708, and (4) support for the Vacuum Chamber Handling Operations in building 4205.

IS (b)(4) [redacted]
Examples of support included: (1) reviewed and approved multiple operational and test procedures for hazardous operations; (2) supported firings of the Booster Separation Motor (BSM) at Test Stand 116 and 24" SRTM ICXL-3 motor; (3) supported de-mil of propellant removed from building 4702 during the Christmas holidays of 2005; (4) supported QD50 at the Impact Test facility ORI, the ET Vented Ramp Panel Test TRR, the Non-Nuclear Testing for Hydrogen Materials, and the Components Development TRR; (5) updated explosive site plan for Building 4564; (6) actively participated in daily and weekly safety meetings/safety stand downs of the MSFC East and West Test Area, S&MA Safety and Quality team and the Engineering Directorate's Test Laboratory; (7) as an additional duty, IS served as the alternate safety representative for test area facilities; and, (8) provided daily support to test engineers and S&MA personnel on technical issues to include performing numerous test procedure reviews.

(b)(4) [redacted] continued their excellent support to SSC S&MA by preparing system safety analyses and presenting test readiness review analysis data to meet the Engineering and Science Directorate compliance requirements at the SSC Test Facility. Programs and projects assessed and continue to be assessed included: IPD (Integrated Powerhead Demonstrator), Advent Engine Test Project, ITA (Instrumentation Test Article), Methane Thruster Test Project, E2/E3 Facility System Hazard Analyses and Mission Essential Fire Protection Systems. In addition, the team prepared Quantity-Distance Maps for the E-2/E-3 propellant tankage placement review and provided comments on the 30% First Response Facility design package. Examples of the technical support function included: participating in design reviews, facility upgrade reviews, weekly telecoms, technical interchanges, scheduling & sidebar meetings, delta tabletop discussions, and preparations for upcoming CRM training, etc.

4.1.2 System Safety Engineering

System Safety Engineering (SSE) supported MSERP internal meetings and the monthly meeting with the SRB team (MSERP0603) and a review of documents for the ET team (MSERP0604) as Executive Secretary, Technical Writer, Senior Technical Support, and Integration Representative. SSE took notes of the minutes of the meeting and continues to write minutes. SSE also distributed to the participants a list of the actions and agreements made at the review. SSE maintained the Process Based Mission Assurance (PBMA) site. SSE reviewed and edited comments for the revision of NSTS 22254.

SSE participated in the Ice Debris and Foam & Non-Ice Debris Summit via telecom and Process PBMA Secure Meeting January 26 and 27. Meeting presentations are available on the Space Shuttle Program's web site.

SSE continued review of draft Crew Launch Vehicle (CLV) System Requirements Review documents, including the CLV to Launch and Mission Systems Interface Requirements Document. SSE also supported Green Run Trade Study, identifying test objectives. SSE supported Upper Stage Functional Flow Block Diagram development. SSE supported development of Ascent Development Test Flight Fault Tree Analysis. SSE supported Staging/Separation Trade Study and identification of separation hazards.

SSE supported the development of an S&MA recommendation for a CLV Safety Risk Matrix. Earlier safety risk matrix definitions were linked to broader program risk characterizations that were not suited for flight hazard cause classification. The object is to develop a set of safety risk matrix definitions that will support the programmatic risk assessment program as well as the individual hazard cause classification that will be part the hazard analyses process and documentation.

The SSME SSE evaluated draft updates of numerous FMEA items being revised to incorporate the AHMS controller upgrade. Several errors were identified during the review, some of which required corrections to related hazard reports instead of the FMEA/CIL, and the SSE recommended corrections for those errors during team review teleconferences held on 01/16/06, 01/20/06, 01/23/06 and 01/25/06. The initial team review of all new Controller FMEA items has recently been completed, and a draft approach for the "generic" retention rationale for the Controller Critical Items List (CIL) was also agreed to. Additional teleconferences will be held starting next week to enable team review and discussion of the remaining AHMS-related FMEA/CIL updates; these primarily involve some electrical harnesses, sensors, and the high pressure turbopumps.

SSE conducted a tabletop review with the MSG Integration Project Team for the Reflown Safety Data Package for Microgravity Science Glovebox re-supply items scheduled for ascent on ULF1.1.

SSE reviewed a document summarizing the S&MA recommendation to the Johnson Space Center Payload Safety Review Panel (PSRP) on recent changes made to payload safety requirements for batteries. The document was prepared in response to an action item given to the MSG Integration Project Team during a telecon held on January 19, 2006. The JSC has created a new form, EP Form 03, and also made changes to the JSC Form 1230 for standardized battery hazard controls and verification methods.

SSE prepared draft slides for a Technical Interchange Meeting (TIM) to be held on February 14, 2006 with the PSRP. The topic of the TIM is the recent on-orbit anomaly where it was discovered that there was damage to the ziplock bag for coil assembly CA-001 of the Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) investigation.

SSE incorporated PSRP comments to the revision of the Microgravity Science Glovebox Phase III hazard report MSG- FL4, "N2 Rich Atmosphere in the MSG WV." The revision is a response to an action item assigned by the PSRP to the Microgravity Science Glovebox

Integration Project during the O_2 Sensor TIM held on November 1, 2005. After MSG Integration Team and US PSRP approval, the revised hazard report will be forwarded to the European Space Agency for review and approval.

SSE is putting together verification packages to close OGS specification safety requirements. SSE met with Hamilton, the OGA contractor, and determined the best course of action for the closure of the remaining OGS safety specification verifications. SSE is also reviewing OGA verifications submitted by Hamilton Sundstrand for closure of hazard control verifications. SSE is coordinating the OGS specification software safety submittal packages in response to the feedback provided by the JSC software safety representative.

The Systems Safety Engineer (SSE) closed out Solar-B X-Ray Telescope (XRT) hazard report verification for a structural loads hazard. The project office certified that the XRT structures and mirrors passed the loads test per NASA STD-5001 requirements. The SSE obtained support from local Solar-B Project Office to provide verification data to support the remaining Solar-B hazard report close-outs.

SSE began writing an instructional Software Safety Document to specify how to implement the requirements and goals of NASA-STD-8719.13B, Software Safety Standard and NASA-GB-8719.13, Software Safety Guidebook. This includes the CLV software safety requirements definition and hazard analysis and the resolution of findings from the Software Assurance gap analysis.

The MSERP hosted a "SERP Face-to Face" at MSFC at the end of February. Worked with NASA Exe. Secretary to draft a preliminary agenda and getting the logistics coordinated for such.

SSE continues to support the hazard assessment of the CLV Upper Stage (US) concept. Activities include the initiation of CLV US preliminary hazard assessment including development of a fault tree to aide in hazard identification. Additional support has been provided for the Separate vs. Nested vs. Common Bulkhead Trade Study which is underway to assess various propellant dome configurations as options for US weight reduction.

SSE supported development of Upper Stage Fault Tree and Preliminary Hazard Analysis. Supported Green Run, Stage Separation, and Bulkhead Design Trade Studies for CLV Upper Stage. SSE supported RCS and avionics design trades. SSE also supported trades by ensuring that safety requirements are identified and met, including fault tolerance/redundancy requirements.

SSE supported the Range safety effort by reviewing the Air Force Space Command Manual 91-710 Volume 4 for impacts on CLV and attending the weekly meetings.

SSE Supported the Risk Based Design (RBD) Integration Panel by drafting an action plan for the CLV Fault Tree and presenting the Fault Tree approach to the project. Also provided status at the RBD Panel meetings. Supported Human Rating Requirements telecom by reviewing current flowdown of requirements from NASA Procedural Requirements.

SSE supported the updating of the top level CLV fault tree by integrating abort modes produced from other analysis. Provided comments and revised safety section of CLV S&MA plan. Conducted meeting between CLV project and S&MA to discuss Fault Tolerance approach. Provided comments to Risk Based Design Panel method of accepting Fault Tolerance exceptions.

SSE supported the 5x5 Hazard Matrix and reviewed the recommendations for updating the matrix were presented to the Marshall System Safety Working Group. The recommendations will require further review and consensus from MSFC management and then will be submitted as recommendations to the Constellation Hazard Report Methodology Document.

SSE continues to oversee and coordinate External Tank (ET) System Safety activities with NASA MSFC and Lockheed Martin (LM). Activities during this time period included: Review, comment, coordination and support for four revised ET Hazard Reports (E.03, P.02, E.06 and S.09). Hazard Reports E.03, P.02 and E.06 were presented to the ET Chief Engineers Review Board (CERB) on Feb. 16, 2006 for review and approval however the CERB requested additional review time. Hazard Reports E.03, P.02 and E.06 were previously presented to the MSFC Safety and Engineering Panel (MSERP) in January and received comments. Those comments have been dispositioned and were discussed at the 2-22-06 MSERP. Reviewed and provided ET System Safety change evaluation assessment of four SSP Change Requests (CRs) and three SSP Requirement Change Notices (RCNs).

SSE supported the regular meetings of the SRB. SSE reviewed the following documents: ECP 4369 – Urgent – Update 10REQ-0021 CRD Requirements, AECP 4403 – FMEA/CIL update to incorporate new failure modes – SRB Camera System, ECP 4399 – Immediate creation of FMEA & CIL for Liftoff Q.D. Ground Probe Assembly, CR S063255B – Revise NSTS 60538, Clarify Space Shuttle Program Government Quality Assurance (QA) Document Review & Audit requirements & Responsibilities, ECP 4335 – Baseline new SRBE hazard report B-95-03, SRB Camera System Debris Source and Failure, ECP 4406 – Immediate update to revise FMEA to reflect ET PAL Ramp Instrumentation – Enhanced Data Acquisition System, and ECP 4353 - URGENT- Add exception to 10PLN-0067 for SRB Camera cables.

The SSE pulled all references to Crack Repair tools as controls in the material RAESR and reported to the JSC tool developers. The tool developer will ensure that all controls are incorporated into the tool requirement documents. The SSE also began to identify the methods of identifying a successful repair while on-orbit and will be incorporating those methods into the RAESR.

The SSE has added the hazard report "Additional damage imposed onto RCC" to the "Safe-to-Repair" ROCR material RAESR. The hazard report will be classified as catastrophic. The most likely cause for additional damage will be from the crew using previously undamaged RCC as a pallet for working the material during repair of the identified damaged region.

The SSME SSE has completed evaluation of a draft engineering change proposal (ECP), ECP number 1486, containing proposed updates to 11 SSME HRs. This is a follow-on to earlier

supported provided for this purpose, for which the SSE traveled to the contractor's facility at Canoga Park, CA and provided multiple review comments during several review meetings held to determine what HR changes would be required due to action items from Integration plus the project's plan to fly protective covers on certain engine sensors to preclude their being affected by LN2 impingement. The draft ECP was supposed to reflect changes agreed to at those earlier reviews, plus responses to the various action items issued at that time. However, this first draft of the ECP contained a multitude of errors; therefore, the SSE documented suggested corrections for each of the 11 HRs (ranging from approximately 10 to 30 comments for each HR), and forwarded them via email to the responsible engineer as well as to the rest of the SSME team involved in this effort. The necessary corrections should be reflected in the official release of the ECP, when it is submitted to MSFC for approval.

Although unable to participate in the nozzle laser brazing CDR on 02/23/06 due to schedule conflicts, the SSME SSE reviewed the complete package of presentation charts for the CDR. Several review comments, including some few safety-related questions that need to be addressed during the review, were documented and provided via email to the QD21 personnel who were able to attend the review.

SSE met with MSERP to update Master Open/Closed Action item list for RSRM. SSE supported Technical Issue meeting for RSRM to discuss ETA Stub blister. SSE reviewed and updated one page summaries of CoFR technical issues that will be presented at the SMRR next month. SSE reviewed and assessed 9 change documents.

SSE reviewed the new issue draft of the GLAST Burst Monitor (GBM) System Safety Program Plan, MSFC-Plan-1047, was approved as written by the GBM Level III CCB on Thursday, February 16. This document is a DID deliverable in the GBM Mission Assurance Requirements (MAR) document.

SSE review comments that were collected from the Materials Science Research Rack MSRR-1 team and submitted to the Safety Review Panel at the JSC. The European Space Agency has submitted the Phase III Safety Package to JSC in preparation for a Phase III review at JSC. The package is for the Materials Science Laboratory (MSL) which will fly as part of MSRR-1.

SSE supported one of two OGS team meeting to discuss the status of the software safety verifications. As a result, SSE provided the ECLSS project with a list of data that Hamilton must provide in order to close the remaining software safety verifications. In addition, SSE reviewed and approved data submittals for 51 OGA Safety Verification Tracking Log (SVTL) items and 44 OGS SVTL items. SSE is continuing to coordinate the development of the OGS specification verification packages for the OGS software safety requirements.

SSE provided support to all of the normal MPLM meetings. SSE began making updates to the Flight ULF-1.1 MPLM/Orbiter Reflight Assessment. These updates are based on the anomaly data from the LF-1 mission provided by the MPLM Project. Additional updates will also be made based on changes to the Flight ULF-1.1 manifest. None of these changes are expected to reopen any MPLM verifications or impact the safety of the MPLM.

SSE completed a revision to the Reflown Safety Data Package for Microgravity Science Glovebox re-supply items scheduled for ascent on Utilization Logistics Flight 1.1. The package was revised to remove the Scavenger Pump Battery and O-Rings from the flight, since a Change Evaluation Form was approved to de-manifest the items. The European Space Agency also concurred with removal of the items. The function of the hand-held, battery operated liquid Scavenger Pump has been replaced by using the new MSG Cartridge Adapter Assembly to interface with the MSG Particle Catcher.

The SSE supported the System Safety Group by reviewing draft proposed Solar-B Hazard Report verification close-outs. Status of these materials was discussed with the SSE who previously supported the project for QA of the System Safety processing of these close-outs.

SSE provided a safety assessment to the Ground Safety Review Panel (GSRP) concerning Braycote grease application to the flight bolts on the Environmental Control and Life Support Systems (ECLSS) Oxygen Generation System (OGS) doors. The Braycote grease was added in an attempt to eliminate friction resistance between the bolt shank and the side wall of the hole. The safety assessment was accepted by the GSDP and processing of the OGS Rack is continuing. SSE also reviewed the Inlet Deionization Bed (DI Bed) Removal and Installation (R&I) procedure that is to be performed after the OGS rack is installed into the Multi-Purpose Logistics Module (MPLM). The SSE comments were incorporated into the procedure. These comments included operational controls identified during the safety assessment for the R&I procedure. The safety assessment will be incorporated into the ECLSS OGS Phase III Ground Safety Data Package as Appendix G.

(b)(4) traveled to KSC to witness the solid rocket motor stacking operation for the next flight. This included the witnessing of all aspects of motor assembly included crane operations, field joint mate preparations, segment assembly and post mate operations. Other activities during the week at KSC were inspection of forward segment propellant grain, RT-455 ablative applications, and field joint protective system assembly.

SSE reviewed and commented on the software safety sections of the initial versions of the CLV Hazard Analysis; Risk Management; and Reliability, Maintainability, and Supportability Plans. Also, authored and provided S&MA Software Safety (SwS) text for those documents.

SSE continues supporting QD10's CLV Flight Safety Systems (FSS) in coordination of the FSS Working Group activities and tailoring the Air Force requirements document AFSPCMAN91-710 to generate the applicable Air Force Range Safety requirements into the CLV and the AFDT-1 Systems Requirement Document (SRD). Also, coordinating the Technical Interchange Meeting (TIM) that is scheduled to be held April 4 -5, 2006, at Patrick Air Force base in Cocoa Beach, Florida.
SSE presented during the monthly MSERP meeting the RSRM status and schedule of RSRM technical issues and change requests that may impact Hazard Reports and CIL's. SSE supported QD-01 Technical Issue meeting for RSRM to discuss TPS debris loss. SSE reviewed and updated one page summaries of CoFR technical issues that will be presented at the SMRR next month. SSE reviewed and assessed 5 change documents.

SSE supported Risk Based Design (RBD) Group meetings by providing input to Fault Tree Working Group Plan and providing comments on approach to acceptance of Failure Tolerance levels. SSE presented CLV Fault Tree Analysis and approach to the Aborts Technical Interchange Meeting. Provided comments to the Project Plan, the Hazard Analysis Methodology Document and the Glossary of Terms for CLV. SSE compiled a list of the accepted Element and Integrated Hazards and their causes for comparison purposes with the CLV Fault Tree.

SSE participated in one of two OGS team meeting to discuss the status of the software safety verifications. SSE helped to establish closure rationale for the remaining software safety spec verifications. SSE reviewed comments from the Safety Review Panel on the remaining four (not yet signed) OGS hazard reports. SSE coordinated with Hamilton Sundstrand to address the SRP comments to the hazard reports. SSE then talked to the SRP representative to reconcile these comments. As a result, SSE updated the four hazard reports and two of the four have been signed by the SRP (closed). SSE reviewed and approved data submittals for 4 OGA SVTL items and 24 OGS SVTL items. SSE also worked with QD30 to develop a plan for the closure of WRS and UPA spec verifications assigned to S&MA.

SSE continued making updates to the Flight ULF-1.1 MPLM/Orbiter Reflight Assessment. These updates are based on the anomaly data from the LF-1 mission and from the ground processing leading up to the Flight ULF-1.1 mission. Updates were also made based on the changes to the flight manifest. A copy of these changes has been provided to the MPLM Project for approval. SSE plans on submitting these updates to the PSRP next week. SSE provided responses to several questions from the PSRP about the capabilities of the MPLM and the items that have been manifested. The PSRP plans to use this information in support of some of their higher level Program reviews.

SSE reviewed one Urine Processor Assembly (UPA) Specification verification for QD30. SSE also met with QD30 to coordinate the closure of the remaining WRS and UPA specification verifications.

SSE provided comments to the Smoke Aerosol Measurement Experiment Investigation (SAME) Phase III Safety Data Package. These comments were in turn reviewed by the SAME investigation team who provided a response, which has been reviewed by SSE. SSE continued preparation of the integrated MSG/SAME Phase III Safety Data Package. A section describing the use of MSG-provided Ethernet cables is in work, as well as a unique hazard report addressing use of gaseous nitrogen by the SAME experiment. The investigation Phase III Safety Review is scheduled for April 4, 2006 at JSC.

SSE performed additional hazard analysis on ground support equipment (GSE) being used on Node 2 to smooth intermodule ventilation interface surfaces and a degassing device. These GSE items have not been used at KSC and safety engineering has reviewed the procedures for their use and the drawings and has provided the analysis to KSC ground safety review panel (GSRP) for their approval.

SSE continues to review Node 3 documentation that is being submitted by AAS to provide verification that all requirements from the Prime Item Development Specification (PIDS) are

satisfied. Any comments that are generated will be submitted via Review Item Discrepancy (RID) system that is being controlled by the European Space Agency. At this time all documents reviewed have been acceptable from the safety standpoint.

HEI continued to promote employee professional growth with a series of training sessions on System Safety topics. These presentations were also open to interested civil service personnel. On February 8, 2006, at the MSFC Monthly System Safety Meeting, System Safety Engineering presented the second half of" Flight System Safety: A Program Life Cycle Challenge". The presentation utilized several major space program events to illustrate the need for a total life cycle safety assessment. On March 6, 2006 System Safety Basics was presented to provide a general over-view of the function, responsibilities and products associated with system Safety. On March 20, 2006, a presentation was made on Hazard Analysis. The presentation outlined the basic role of hazard analysis in a program's life cycle, illustrated the basic analysis technique with a class problem and closed with a list of analysis "helpful hints".

4.2 Reliability

Reliability & Maintainability Engineering (R&ME)

During the 2nd Quarter of Fiscal Year 2006 Reliability and Maintainability Engineering (R&ME) continued to support the Constellation Program (QD10) through its involvement in meetings and telecons regarding reviews, comments and revisions in order to provide status, discuss recent issues and possible future changes/modification to the Constellation Program's FMEA/CIL Methodology requirements document. As a result of such involvement R&ME reviewed the top level CLV Upper Stage Reliability Allocations for this reporting period and revised its draft to align it with the Constellation document and also to continue to provide for a more in-depth analysis needed for the CLV Project, as well as conducting a review and providing comments on the CLV's System Requirements Document (SRD), Operations Concept Document and various interface requirements documents. Also this period R&ME was assigned as the FMEA/CIL working group chairman by QD10 and tasked with updating the CLV FMEA/CIL Methodology document, sending it out for review along with creating charts for the Functional FMEA Tiger Team kickoff meeting and formulating the Functional FMEA action plan. Reliability & Maintainability Engineering (R&ME) provided support to all ongoing Functional FMEA Tiger Team activities this quarter as well as providing guidance and input to the Upper Stage Engine (J2 derived) Functional FMEA. In addition to this effort R&ME was tasked with updating the Functional FMEA template with examples and definitions.

Reliability & Maintainability Engineering (R&ME) participated in helping to kick-off this quarter's Risk Based Design (RBD) Integration Group. The RBD Integration Group was chartered under the CLV Vehicle Integration element and is tasked with implementing and coordinating the reliability, maintainability, supportability, integrated hazards, costs and operations for the integrated CLV stack, across all the CLV elements, with Level 2 and within the Vehicle Integration Office.

Reliability & Maintainability Engineering (R&ME) supported the Stage Separation and Green Run Trade Study Teams this quarter by identifying and providing a formal method of reviewing options and the associated Figures of Merit (FOM) for each option. R&ME has had a significant input into the selection of the most appropriate options this period and has also provided inputs

to the Green Run Trade Study "mid-term report" based upon issues seen involving Reliability, Safety, and Mission Assurance. One issue that R&ME was involved in resolving on the Upper Stage Green Run Trade Study was to assess whether or not hot-fire testing would be required as a part of the Qualification Test Requirements. This concern was raised by the Upper Stage Project Office due to the current version of the CLV Con-Ops document requiring that each flight Upper Stage be hot-fire acceptance tested (green run) with its Upper Stage engine before every launch.

Reliability & Maintainability Engineering (R&ME) was called upon to support this quarter's Upper Stage Documentation Review by reviewing a number of CLV documents, consisting of the CLV SRD, CLV-CEV Interface Document, CLV-LMS Interface Document, CLV ConOp Document, and the Constellation Architecture Requirements Document.

Reliability & Maintainability Engineering (R&ME) assisted the Upper Stage Functional FMEA Tiger Team's initial development of a fault tree based failure analysis that would lead to an "initiate abort" command. This Functional FMEA was focused at the top level events in areas of Propulsion, GNC, Data Management, Thermal Management, and Electrical Power. Reliability & Maintainability Engineering (R&ME) also helped with the development of a Functional FMEA methodology to be utilized for the element level Functional FMEA in preparation for SRR. Ground rules were identified and a template established for consistency across all the elements. In preparation for this FMEA effort, a top-level Upper Stage Reliability Block Diagram (RBD) was also drafted and submitted for review.

Reliability & Maintainability Engineering (R&ME) provided support to QD11's effort associated with the initial review of the CLV/ Ascent Development Flight Test (ADFT) Functional Flow Block Diagram, the ADFT Functional FMEA and the ADFT Fault Tree development this quarter. The ADFT Fault Tree was identified as a deliverable for the 2006 SRR and had undergone several changes/modifications to reflect comments generated from its many reviews and weekly meetings, held to drive the fault tree down to its lowest levels of detail. However because S&MA never received funding to support the ADFT R&ME's involvement has ceased and the ADFT's development is now being carried out through mainline project activities, such as the RBD group.

Reliability & Maintainability Engineering (R&ME) supported this quarter's Inter Stage Separation and Trade Study Teams. An initial concern focused on possible damage to the upper stage engine if the inter stage was left attached to the upper stage before separation of the two occurred. Reliability & Maintainability Engineering (R&ME) obtained a copy of the New Horizon Pluto Probe PRA for review to determine the risk concerns.

Reinforced Carbon-Carbon (RCC)

Reliability and Maintainability Engineering (R&ME) continued to provide dedicated support this quarter to QD20's Reinforced Carbon-Carbon (RCC) Crack Repair Material (CRM) project by updating the FMEA/CIL and P-FMEA's for the "Safe to repair" Risk Assessment Executive Summary Report (RAESR). Reliability & Maintainability Engineering (R&ME) was also given the task of performing a FMEA on the ROCR repair tool kit that would be used by the astronauts. This tool kit will consist of the following items; Scrapers, Manual Crack Repair Gun,

Palette, Crack Repair Bag and EVA Thermal Sensors. The tool kit is to be used in case an in orbit repairs is required due to debris/strike damage to the orbiter. A special week long meeting was attended this quarter by R&ME in order to assess and better understand the limits and characteristics of the Crack Repair Material (CRM) and how this material will interact with the tools involved if and when a repair is required. R&ME has also developed the worksheets to be used in documenting and recording the analysis and is currently postulating the many different failure modes that could be encountered when using the tools of the repair kit.

External Tank (ET)

Reliability and Maintainability Engineering (R&ME) also continued to provide support this quarter on the following ET issues: Addition of heaters to ET's aft bellows effort. The current lead design is using existing certified heaters with a "quick release" electrical leads; ET-117 Limited Life Assessment: Evaluating limited life of spray acreage foam on ET-117, as well as the ECO sensors; ET Limited Life Workbook: Constructing a workbook containing limited life data as a result of the ET-117 study; First flights of old process BX-365 closeouts in CDZ: Evaluations were conducted on when these closeouts flew in order to give a better understanding of potential foam loss/ debris problems. Reliability and Maintainability Engineering (R&ME) also attended the status telecoms to receive updates on ET work being performed at MAF and KSC to monitor any potential problem source and participated in weekly telecom to status the external power box (EPB) design progress. Reliability and Maintainability Engineering (R&ME) continued its participation in telecons, meetings, and testing of the bipod bolts and to address issues arising from deviations in test procedures as well as assessing the reliability impact of launching/flying without PAL ramps. R&ME continued its efforts with developing a presentation to the ET Project Office to determine pros and cons of flying with PAL ramps removed vis-à-vis PAL ramps in place. Part of this effort included assessing the reliability impact of flight without PAL ramps and provided input for test plan and procedure to ensure reliability, feasibility, and validity of tests to be performed, and whether tests were bench, system, or component. R&ME participated in this quarter's Engine Cut-off (ECO) sensor anomaly discovery team telecoms and TIM held at USA on 9 & 10 January, to develop test requirements for further testing as well as in the TRR for Bipod Bolt Testing issues and MSERP.

Reliability and Maintainability Engineering (R&ME) monitored ET's Aft Bellows Heaters concept that was presented at this quarter's Debris Summit. The S&MA team did not receive a sense of urgency on the concept and decided to go forward with a non-tethered approach. R&ME was also involved with the RTF II Ice Frost Ramp Rationale Development by moving forward with test plans for the ice frost ramp. R&ME coordinated tests between IFA teams to ensure that S&MA covered the full spectra of what needs testing. The test plans were updated real time with data that came in from MAF in regards to the dissection of ET-120. The team finalized the test plan for 3'x3' test articles (Test plan 809-8527), had the test signed and test articles fabricated. The test was designated as a Risk Assessment test and not a Qualification for Flight test, therefore only the test articles to 7 cryo-cycles in the test were subjected which is consistent with ET's tanking history. Should the test for certification be required, later tests will include a full 13 cryo-cycles. The team ensured that the test articles were large enough to encompass historical foam losses without test article edge interference.

Space Shuttle Main Engine (SSME)
Reliability and Maintainability Engineering (R&ME) supported by PWR-West (Pratt &Whitney/ Rocketdyne – Canoga Park) conducted a series of AHMS FMEA/CIL Face to Face meetings this quarter to update the existing Baseline SSME FMEA/CIL and Hazards for an updated SSME Controller. The New modified controller incorporates an Advanced Health Monitor System (AHMS) and will also use an advanced real time turbo-pump vibration monitoring system. This Real-Time Vibration Monitoring System (RTVMS) was developed by the Marshall Space Flight Center (MSFC) for Space Shuttle Main Engine (SSME) high-speed turbo-machinery vibration diagnostics and failure mitigation. The implementation of RTVMS into the SSME Controller and HMC in the AHMS for Shuttle flight operations will provide obvious benefits derived from the system's ability to mitigate potential engine catastrophic failures and enhance Shuttle safety and reliability. Probability of catastrophic SSME failure reduced by 25% improved capability to determine and manage engine health in real time and post flight/test.

Solid Rocket Booster (SRB)
Reliability and Maintainability Engineering (R&ME) routed and reviewed the Certificate of Qualification (COQ) for the upgraded IEA wire harnesses this quarter. The paperwork was in order and the correct reports were placed in the package at the request of R&ME. S&MA is now awaiting concurrence and signature from the Solid Rocket Booster (SRB) Project Office to officially close out the COQ review process.

Reliability and Maintainability Engineering (R&ME) reviewed the FMEA/CIL's submitted by United Space Alliance (USA) for closure of RID's initiated by R&M during the SRB Camera System CDR. USA met the criteria for RID closure and submitted an implementing Engineering Change Proposal (ECP) to baseline the FMEA/CIL's in compliance with NSTS 22206. All FMEA/CIL submittals were presented to the Marshall Safety Engineering Review Panel (MSERP).

Reliability and Maintainability Engineering (R&ME) participated in a process audit of the newly installed IEA upgraded distributor and signal conditioner harnesses at vendor L-3 S/N. The process audit was conducted on IEA S/N 53 (Aft IEA) at 75% production of installation. The process audit centers its review on Procurement Controls, Fabrication Controls, Testing, Inspection, and Evaluation Controls, Process Controls, Nonconformance's, Training and Stamp Controls, Bonded Storage, and Metrology. The audit team was split into two teams to complete the audit. There were 7 reported findings against L-3, 5 reported findings against USA, and 1 observation against L-3 S/N. L-3 and USA were given 30 days from formal submittal to respond to the findings.

Reliability and Maintainability Engineering (R&ME) supported the review and analysis of the new (ASA). The ASA is scheduled to fly on BI-131 (STS-119) and was originally qualified in the 2003 time-frame. In response to a recent GIDEP advisory, a risk assessment was performed of the Actel FPGA due to infant mortality rate of about 5.5%, a recommendation was given by MSFC EEE parts to subject all new ASA's to a 500 hour burn in with no risk of harmful stress on the units. The burn in should bring down the infant mortality rate to just above 1%. In addition, ASA Engineering Development Unit (EDU) #4 which has been trended since 09/2003, was shown to have exceeded it's upper tolerance limits due to "drift". Due to the "drifting",

recalibration was performed on eight units that are to be sent to L3 Cincinnati Electronics (CE) in the near term. The data allowed the SRB Project to determine the frequency to which recalibration is performed.

Reliability and Maintainability Engineering (R&ME) traveled to Integrated Electronics Assembly (IEA) Harness vendor LeBarge located in Joplin, MO. The purpose of the trip was to troubleshoot and isolate the cause of multiple pull test failures occurring on the Solid Rocket Booster (SRB) IEA Harness Upgrade program. LeBarge had three documented failures of pull tests occurring between August 2005 (1 failure) and January 27, 2006 (two failures between 01/23/06 and 01/27/06). All three failures occurred on Cannon connector supplied contacts. A fault tree was developed and was worked to the lowest level of detail. However many of the fault tree blocks could not be closed out until Sherry Labs issued a full report on the Destructive Physical Analysis (DPA) of a failed contact. Fault tree blocks regarding operator error, operator training, and crimp tool calibration were closed but a specific crimp tool (S/N 5397) is still in question. The failure analysis team continues to work the issue and all crimping activities regarding contact S/N 515014 have been stopped until the failure is isolated.

Reusable Solid Rocket Motor (RSRM)

Reliability and Maintainability Engineering (R&ME) was responsible for seeing that several PRACA items were processed this reporting period; 1) Discoloration and Indentations on center field joint J-leg insulation, RSRM-92B: full closure approved 2/9/06; 2) Foreign Material found on Joint 2 Secondary o-ring, PRM-1:Request for full closure submitted and in MSFC review; 3) Heat Effect on S&A Gasket Primary Seal Cushion and Crown, LAT-75:Request for full closure submitted and in MSFC review; 4) Fiber found Across Nozzle Joint 1 Secondary o-ring, RSRM-90A preflight: Problem opened in MSFC PRACA; 5) Blistered Paint on the Aft ET Attach Stub, RSRM-90B:Problem opened in MSFC PRACA. MSFC PRACA report A18165, Systems Tunnel Adhesive Large Non-Bond, RSRM-92, was opened in the PRACA system on 2/20/06.

Space Shuttle Program (SSP) Integration

Reliability and Maintainability Engineering Integration (R&MEI) continued to support the regular Operations and Maintenance Requirements and Specifications [OMRS] Working Group this quarter by coordinating all of KSC's comments concerning the many RCN's. Reliability & Maintainability Engineering (R&ME) also attended and participated in regular Launch Commit Criteria [LCC] Working Group meetings and evaluated NINE integrated change request and provided comments to QD20 i.e. CR S050425DA, CLOSURE OF ISPR-05 INTEGRATED HAZARD REPORT - identified incorrectly cited OMRSD requirements. R&ME suggested replacements for these entries and identified OMRSD requirements cited in the body of this report but do not appear in the OMRSD REFERENCE table; R&ME also evaluated nine [9] integrated change packages and provided comments to QD20. R&ME recommended disapproval of CR S063255A, Revise NSTS 60538, Clarify Space Shuttle Program Government Quality Assurance [QA] Audit Requirements and Responsibilities because of contradictions associated with the methodology for conducting such audits. The change directed sampling using the Acceptable Quality Level [AQL] methodology while instructing S&MA to conduct audits using the process control and continuous improvement methodology.

International Space Station (ISS) Payloads

Reliability & Maintainability Engineering (R&ME) completed sixteen distinct OGS specification requirement verification reports this quarter in parallel with completing its OGS FMEA/CIL Analysis, OGS Maintainability Analysis, and OGS Limited Life Items List of the REGEN ECLSS OGS. R&ME coordinated these efforts with JSC ISS R&M Panel Chair and Boeing Huntsville R&M personnel on several occasions in the processing of the documents for completion. R&ME has received no additional comments in regards to the latest updates of the OGS R&M documents. The OGS S&MA lead is currently obtaining signatures on these documents.

Reliability and Maintainability Engineering (R&ME) is currently reviewing and updating the current WRS R&M document deliverables in order to incorporate them into the final revision. Final approved documents are to be provided no later than early April, '06 (which could potentially slip due to a delay of the FCA/PCA until June, '06). R&ME has also identified 28 distinct R&M related specification verifications that will need to be worked concurrently with the document's development.

Reliability & Maintainability Engineering (R&ME) met with members of the GLAST BURST MONITOR (GBM) Project Office this quarter, to discuss the schedule for completing the Data Item Descriptions (DID's) on GBM. As a result of this meeting R&ME received one action concerning its completed preliminary FMEA (DID 311). The action was to re-write/re-word the analysis showing that all parameters were set at the worst case limits, and that worst case environmental stresses for all parameters were considered and that all operations had been evaluated. MSFC S&MA requested that an Engineering Order (EO) be submitted for the GBM FMEA and the Worst Case Analysis.

R&ME was also in contact with System Safety and Reliability of GSFC this period to explain the philosophy of the GBM Power Box FMEA. Questions were raised about interface failure modes between the GBM and the LAT but R&ME provided the reassurance and rationale that the failures were benign to the LAT.

R&ME held a teleconference with GSFC's GBM Project Office in order to determine the adequacy of the GBM FMEA's to satisfy the GLAST requirements. Currently R&ME has since made preparations to close the documentation on the GBM FMEA, the GBM Worst Case Analysis and to combine the GBM Power Box FMEA and the DPU FMEA into one document. MSFC is currently waiting for additional documentation from GSFC Reliability to be included into the document. The primary mission of the GBM instrument is to support the Large Area Telescope (LAT) in observing gamma-ray bursts by providing low-energy measurements with high time resolution and rapid burst locations over a large field-of-view.

R&ME coordinated with its U.S. point of contact (Sverdrup) this quarter to have the MSRR-1's FMEA work sheets for the Material Science Laboratory (MSL) sent to European Space Agency's (ESA) in order to gather additional information on the MSL sub-system. In the interim R&ME continued to finalize it's analysis on the MSRR-1 while also waiting to receive two "time to detect" failures from Engineering in order to complete the Microcontroller FMEA. The Microcontroller information has since been received and the MSSR-1 Microcontroller FMEA has been delivered for inclusion in the verification data package.

4.2.2 Problem Assessment Center Operations

HEI's PAC personnel processed and coordinated disposition of problem reports; coordinated the MSFC Problem Assessment System; performed and coordinated problem processing; worked with SE&I in performing and organizing future Integration In-Flight Anomaly (IFA) processing; discussed issues and offered suggestions to the Constellation (Cx) PRACA Methodology Team and Cx PRACA System Team, took responsibility for basic MSFC PRACA data system administration; provided real-time problem data support for the STS-121 MMT Countdown Simulation, and operated the Corrective Action System (CAS). The PAC received and entered 17 new problem reports (PRs) into MSFC's Problem Reporting and Corrective Action (PRACA) System, coordinated MSFC interim closure of 15 PRs, received 30 prime contractor closure recommendations, supported MSFC full closure of 38 PRs, coordinated non-problem closure of 3 problems, and performed 778 individual PR database updates and reviews. We conducted 4 SSME problem review boards (PRBs) resulting in dispositioning 17 problem reports. We reviewed 7 requests for access to the MSFC PRACA database and granted all of them. We assumed administrator responsibilities for processing new MSFC PRACA User ID requests and coordinated MSFC review and approval of an updated Interface Definition Agreement (IDA) between MSFC S&MA and webPCASS.

In support of the Shuttle Program Assurance Office, PAC worked through the Shuttle PRACA Working Group in PRACA data clean-up and developed and presented PRACA training for SE&I Integration IFA processing. PAC generated and distributed a weekly open PRACA problems and ALERTs metric to show progress toward resolution of all issues prior to shuttle missions. PAC also participated and coordinated MSFC review of a NSTS 08126 PRACA change request (CR S063211A) regarding risk, trending, and IFA time frames (including assisting in developing the IFA process flow diagram) and distributed review materials to MSFC participants in the teleconference. PAC also trained 22 Integration personnel (from MSFC, KSC, and JSC) regarding PRACA approaches as well as data entry for Integration IFAs for future Shuttle missions.

In support of the Constellation System (CS), the PAC represented MSFC and the Draft 2 PRACA Methodology Development Team in California at the Ames-led Cx PRACA System Team. I explained the thinking put into requirements of the Draft document and made suggestions for adapting it to the proposed process-oriented system. HEI also was appointed to take the lead in finalizing and obtaining approval for the Constellation PRACA Methodology document. (b)(4)

(b)(4)

The PAC provided various problem data in support of NASA and MSFC analyses. Regular activities included providing daily KSC PRACA shuttle problem summaries, daily MSFC PRACA open-against-next-mission summaries, daily KSC Resident Office reports, monthly newly opened/closed problem summaries, weekly SRB PRACA and ALERT activities and status reports, and quarterly Open Problems List (OPL). In special engineering analyses activities, Problem Assessment Engineering: 1) Provided and discussed background data to the Shuttle PRACA systems auditor; 2) Researched and provided KSC and MSFC PRACA data on Ground

Umbilical Carrier Panel problems; 3) Extracted and presented problems on MPS metallic contamination; and 4) Obtained and provided KSC and JSC tin whisker problems.

In problem trending, we continued to apply improved techniques for recurring problem identification, analysis, and presentation. The PAC continued to support the NESC Data Mining and Trend Analysis (DM&TA) Working Group by working to provide them with MSFC Shuttle data to include in the data mining application developed by Ames.

In implementation and operation of the MSFC Corrective Action System (CAS), we received 26 potential CAS reports, screened 25 draft Recurrence Control Action Requests, elevated 3 to new Recurrence Control Action Requests (RCARs), coordinated 5 point of contact (POC) responses, and facilitated 3 Corrective Action Boards (CABs) resulting in closure of 3 RCARs. We explained the CAS process at a Marshall Management System (MMS) Implementation Team meeting and tightened up processes for identifying, highlighting, and correcting slow/delayed RCAR responses.

4.2.3 ALERT Program

HEI's ALERT support included both regular and special activities as we coordinated MSFC ALERT processing and participated in the NASA and general Government-Industry Data Exchange Program (GIDEP) activities. HEI received and distributed 16 ALERT announcements for MSFC review and obtained 1,152 responses from MSFC project, contractor, and laboratory contacts. HEI ALERT support included: 1) reviewed and approved 6 new MSFC ALERT database accounts via the TPS security; 2) generated monthly Open, Delinquent ALERT response tabulations and provided them to S&MA and Directorate single points-of-contact responsible for open ALERT reduction; (3) initiated review by NASA HQ OSMA of providing Supplier Audit System (SAS) data to GIDEP; (4) developed and assisted revision of documentation associated with the NASA Advisory Forum; (5) maintained a low delinquent response level (maintaining 120 or less delinquent responses for the last 3 month); (6) finalized and coordinated release of MSFC-initiated NASA Advisory NA-MSFC-06-01 regarding BAE RAD 6000 boards; 7) presented a 30-minute overview of ALERT document types with examples to the System Safety Discipline Team and NASA HQ (Frigola) Audit Team; and 8) participated in the GIDEP Quarterly Business Session at San Diego, specifically addressing plans for the November 2006 clinic and ITAR/EAR issues. The PAC also provided monthly ALERT data and meeting support to the MMS Implementation Team and to the Management Safety Review (MSR).

4.3 Quality

Space Transportation

Space Shuttle Main Engine (SSME) Quality Engineering (QE) supported an Implementation Audit of the MSFC SSME Government Quality Plan. Audit was successful with only minor finding noted. SSME QE traveled to Canoga Park, CA and participated in the MSFC Configuration Audit of Pratt and Whitney Rocketdyne. The MSFC team documented 8 finding and 8 observations. SSME QE participated in the Non Integral Ignition System (NISIS) Cover Critical Design Review. This cover is being added to protect the electrical components sensitive to cold inside the NISIS Box. SSME QE participated in the SSME engine nozzle laser brazing preliminary design review. In conjunction with the S&MA Combustion Devices Lead, QE

initiated an action item for Pratt & Whitney Rocketdyne (PWR) to submit their detailed procurement quality planning as well as detailed plans for configuration identification/control prior to initiation of the purchase orders. SSME QE recently evaluated verification/certification changes made to the Kevlar insulation system of the high pressure fuel discharge, rigid fuel bleed, articulating fuel bleed and low pressure fuel discharge ducts. QE recommended several corrections be made to the documents.

Solid Rocket Booster (SRB) QE supported the ATK Booster Separation Motor (BSM) Burn Rate Anomaly Resolution Team (ART) providing assistance the with the creation of a logic tree to help define the sources of variability that affect the propellant burn rate and is assisting in recommending a series of mixes to understand the propellant sensitivity.

SRB QE continued support to the ATK BSM Alternate Source Team working problems associated with the alternate source such as; the liner surface preparation and grit blast process and the proposed to change the O-ring material to be qualified for the new BSM.

SRB QE participated in the NSTS 60538 Audit by Johnson Space Center (JSC) quality auditors at the Kennedy Space Center (KSC). QE supported work being completed by Defense Contract Management Agency (DCMA) and Resident Management Office (RMO) personnel at KSC. JSC auditors supplied a checklist of sections from the NSTS 60538 document that will be audited. KSC DCMA and RMO personnel completed the checklist items and the QE supported this effort by reviewing the list with the RMO and DCMA representatives. The QE also updated the SRB QP to eliminate any references to an RMO QP.

SRB QE attended the first test firing of the BSM motors on the newly installed BSM test stand. The previously used BSM Test Stand has been shipped to MSFC and reassembled in the East Test Area. The BSMs were successfully tested.

SRB QE participated in the Phase III, Flight Certification Review for lot ABD SRB Frustum Separation Assemblies at Universal Propulsion Company-Aircraft Interior Products (UPCO), Fairfield, California. The MSFC/USA team performed visual inspection of the flight hardware; evaluation of x-rays; and review of manufacturing, test, and inspection records.

SRB QE supported Automated Dynamic Acceptance Test Stand (ADAPTS) to status upcoming activities in preparation for delivery of unit to Parker-Abex. The activation testing is continuing as the engineers continue to work thru various hardware, software and interface issues.

SRB QE participated in the final ATK BSM Manufacturing Readiness Review (MRR). During this MRR the nozzle assembly, liner surface preparation, liner and propellant testing, motor final assembly, igniter and motor x-ray, and BKN03 bagging processes will be reviewed. All documents to be reviewed are available except the X-Ray technique sheets.

SRB QE completed an assessment of the SRB Nose Cap Thruster Pressure Cartridge Phase I design drawing package submitted by United Space Alliance. Review comments were provided in preparation for coordination with the hardware supplier, Universal Propulsion Company-Aircraft Interior Products (UPCO), Fairfield, California.

External Tank (ET) QE provided support to the ET Diffuser Source and Process Change Team. There was a change in a welding process and a source location change for the diffusers. The QE's drafted a letter explaining a contradictory position to the Lockheed Martin (LM) Assessment Teams conclusion that no re-qualification of the diffuser was necessary.

ET QE supported the Space Shuttle Program "gap assessment" of the ET S&MA for compliance to NSTS 60538. Two minor observations and two gaps were written. The Gaps documented that ET S&MA had not implemented all areas of the newly implemented ET Quality Plan and that a Government audit group needed to be established and implemented.

ET QE participated in a Technical Interchange Meeting to discuss NDE results of data gathered during tank foam inspections/dissections. Form inspections using NDE detection techniques Backscatter, Terahertz, and Shearography, are being predominately conducted at MSFC, KSC, MAF, Langley, and Glenn. These techniques are being used to develop processes for damaged foam detection for External Tanks.

ET QE supported a Test Readiness Review (TRR) for (ET) Thermal Development Test for Vented Ice Frost Ramps. This test was to reduce the potential for foam loss. The testing involved adding vent holes to the Thermal Protection System (TPS) similar to what is currently performed on the intertank acreage TPS, which has been successful in reducing the foam loss in the intertank region.

Reusable Solid Rocket Motor (RSRM) QE participated in a Phase III; Flight Certification Review of 4 RSRM Ignition S&A Devices at KSC. The MSFC/ATK team witnessed the performance of receiving inspection acceptance tests; performed visual inspection of the flight hardware; evaluated x-rays; and reviewed manufacturing, test, and inspection records. As a result of the certification review, 3 of the 4 units were found acceptable. One unit was rejected by the Phase III Review Team.

RSRM QE supported the RSRM Nozzle Severance LSC Phase I/II, design baseline and pre-production review conducted at Ensign Bickford Aerospace & Defense (EBA&D), Simsbury, CT. The team assessed the progress of the EBA&D hardware development effort and reviewed current design, manufacturing, inspection, and test documentation.

Launch Systems Assurance (LSA) QE supported the Integrated Powerhead Demonstrator (IPD) Test Anomaly Investigation. The IPD Anomaly Resolution Team (ART), presented its findings to independent reviewers at MSFC, Aerojet, Air Force Research Lab (AFRL), Stennis, and White Sands Test Facility.

LSA QE supported the Development of Autonomous Rendezvous Techniques (DART) Project activities, a few items remain to be accomplished in order to close the books on the DART Project completely. QE was requested to assist in the physical transfer of the last two Sun Work Stations, from the DART Project Office to the MSFC Robotics Laboratory, (EV21).

LSA QE supported the Crew Launch Vehicle (CLV) S&MA Integration Office with the continued development of Quality Assurance Requirements and participated in the continuing meetings for the development and updating of a CLV DFT-1 Fault Tree based on inputs from KSC & JSC.

LSA QE supported activities for the CLV upper Stage (us) providing quality requirements for the S&MA Quality Plan. The QE provided input to the Manufacturing and Assembly (M&A) Integrated Product Team (IPT) related to risk actions once key processes, Preliminary Hazard Analysis, Critical Items List and Failure Modes, Effects and Analysis have been developed.

LSA QE provided quality requirements for the Upper Stage S&MA Quality Plan. Quality Engineering also provided comments on the Draft CLV Level II Master Test & Verification and S&MA Plans. The QE provided input to the Robotic Friction Stir Welding System Specification for Solicitation.

QE supported the On-Orbit Crack Repair (ROCR) Project providing testing support the development of a model to predict the behavior of NOAX used to repair any damage to the Orbiter.

Software Assurance
Software Assurance (SA) continued to support the Material Science Research Rack formal verification and validation testing of flight software Operational Increment 3.0.3.4.

SA participated in the Software Engineering Institute Capability Maturity Model Integrated Level 2 Assessment.

Software Assurance (SA) provided inputs to the Software Review Board (SRB) which convened to approve release of the Material Science Research Rack (MSRR) Enhanced Master Controller Unit Tester (EMUT) support software, version 3.5.1. Software Assurance (SA) witnessed formal verification and validation (V&V) regression testing of the Material Science Research Rack (MSRR) flight software Operational Increment (OI) 3.5.00.

ISO/AS9100
QE has continued to play a key role in ensuring the maintenance of ISO 9001 and AS9100 at MSFC during this time period. Efforts have dealt with continuing implementation of ISO 9001 and AS9100, maintenance of documentation, and planning and support for the NQA registrar surveillance audit, including escorting during the audit, and follow-up and closure of corrective actions. QE provided general ISO and AS9100 support, including Integrated Management System Board (IMSB) meeting preparation; reviews of both MSFC and NASA Agency documentation; and consulting support on internal audits, continual improvement, customer satisfaction, quality objectives, management review, and other aspects of ISO 9001 and AS9100 to various MSFC Organizations.

Payloads
QE performed drawing reviews, procedure reviews, test readiness reviews, and procurement reviews, inspection requirements, shipping requirements, and supported team meetings for the

Environmental Control Life Support Systems (ECLSS), GLAST Burst Monitor (GBM), Material Science Research Rack (MSRR), Solar-B, and Microgravity Science Govebox (MSG) projects. QE continued review and provided comments for safety verification closures for ECLSS. QE provided quality expertise to Material Review Boards for ECLSS, MSRR and MSG.

Quality Engineering provided Quality Requirements/Support for the return of LOCAD Space Flight Quality Sensitive Hardware from KSC.

Quality Engineering supported the Environmental Control and Life Support System (ECLSS) reviewing the Oxygen Generation System (OGS) Inlet Deionization Bed Removal and Installation test procedure. QE worked OGS verifications. QE reviewed the Water Recovery System (WRS) wire harness drawing and Engineering change Orders. QE also provided quality requirements for purchasing space flight hardware for Urine Processor Assembly (UPA) and ECLSS spares. QE provided quality shipping and receiving requirements for OGS hardware that was shipped to Kennedy Space Center (KSC) and received from Hamilton Sundstrand Space System. QE supported the Physical Configuration Audit (PCA). QE has reviewed build paperwork, drawings, engineering change orders, supplier Acceptance Data Package (ADP) for build materials, configuration issues involving as-built versus as-design, waivers and deviations.

Quality Engineering conducted audits of the Tunable Filter (TF) documentation and witnessed hardware modification of the TF and replacement of a FPP Winchester connector. Closeout procedures for the TF Focal Plane Package (FPP) were monitored at the NAOJ clean room for the Solar-B project. A review of FPP Acoustic test procedures and the Acoustic Test Facility at the Japanese Aerospace Exploration Agency (JAXA) in Tskuba, Japan was conducted. A review of the Thermal Vacuum Test Facility and the SOLAR-B spacecraft integration clean room at the Institute of Space and Aeronautical Science (ISAS) at Sagamahara, Japan was conducted.

Inspection and Test

Quality Assurance (QA) personnel continued support to the ET / SRB Return to Flight testing and inspection activities. QA personnel continued to support the manufacturing, and inspection of ET Foam test specimens. QA personnel continued to witness the application of Hypalon onto Hentzen topcoat qualification test panels.

QA personnel supported the Environmental Control Life Support Systems (ECLSS) Project with inspection and data review activities. Inspecting / reviewing work orders and data for the Distillation Assembly, Water Recovery System (WRS) Rack, and the Oxygen Generation System (OGS) Rack Assembly sub-tier work orders. Monitored PCH moves of Rack #1. Inspect / review the WSTA Qualification Unit Acceptance Data Package.

QA personnel supported the Microgravity Science Govebox (MSG), Material Science Research Rack (MSRR), Lab-On-a-Chip (LOCAD), Solar-B, g-LIMIT, and GLAST Burst Monitor (GBM).

QA personnel provided hardware inspection, test surveillance and document review support to the following QD10 projects: External Tank Return to Flight Testing, 24" Solid Fueled Motor

High Pressure Grain Test, and weld inspections on the new facility gaseous hydrogen piping at Test Stand 115.

Test Area QA personnel performed Visual Weld Inspections on two mobile carts that were fabricated for storing the 24-inch Solid Rocket Test Motor (SRTM) test article in the Test Area explosives storage bunker.

Test Area QA personnel continued the ongoing long-term baselining effort of the Test Stand 500 facility mechanical engineering drawings package as time and weather permits.

Test Area QA personnel generated a nonconformance QTPS (Quality Test Preparation Sheet) describing the expiration of the calibration date of two flowmeters installed in the KT Engineering (KTE) position at Test Stand 500.

Test Area Quality Assurance personnel (QA) maintained surveillance during BSM test at Test Stand 116. QA performed a visual inspection of the test article upon arrival at the test stand, and then witnessed the installation of the test article into the BSM test position.

QA personnel compared the As-built configuration verses the As-designed parts lists of the Oxygen Generation System Top Assembly.

QA support of the Environmental Control and Life Support System (ECLSS) Spares activities, performing inspection of printed wiring boards received from Electro Plate. QA provided support to the Environmental Control and Life Support System (ECLSS) Physical Configuration Audit (PCA).

QA personnel are evaluating the receiving information and Acceptance Data Package for the Forward and Aft Booster Separation Motors (BSM). Quality personnel performed the primary visual inspection of the shipping container and initial inspection of the P/N 64809/10317-0002-806, S/N 4004076, Lot Number ABM; BSM prior to being removed from the shipping container. Following the removal from the shipping container and installation into the test stand, a visual inspection was performed to confirm the Pratt & Whitney / Chemical Systems Division Cosmetic Condition Report. No other discrepancies were noted.

QA personnel supported the Glenn Research Center (GRC) customer supplied product testing and inspection of Quick Disconnect (QD) components and witnessed the assembly.

QA personnel supported the Material Science Research Rack, Solid State Power Control Module (SSPCM) monitoring troubleshooting of the SSPCM flight unit.

QA personnel monitored testing of the External Tank Attach (ETA) Ring Camera and the Failure Analysis of a failed Engine Cut Off sensor.

Test Area QA personnel maintained surveillance during the: 1) KT Engineering (KTE) test #17 at Test Stand 500, 2) a check out of the control ignition system for the BSM test series at Test Stand 116, and 3) a re-configuration of the RS-68 Subscale test article at Test Stand 116.

QA personnel are supporting: 1) the Liquid Oxygen/liquid Methane (LOX/LCH4) Thruster Test, 2) the testing of Real Time Radiography (RTR) test, 3) the testing of External Tank (ET) foam test panels at the Improved Hot Gas Facility (IHGF) and 4) testing of the RS 68 40K Thruster.

QA personnel are supporting the development and review of the test procedures to be used in testing of the Thermal Development Test for Vented Ice Frost Ramp.

QA personnel is assisting in the preparation of g-LIMIT for shelving including witnessing the procedure for preparing both the flight unit and flight unit spare for storage and updating parts tags to the correct configuration for storage.

4.4 Information Management (IM)

Information Management (IM) released a revised Supervisor Safety Web Page (SSWP) application during the quarter. Numerous improvements were incorporated into SSWP and the application was revised to incorporate the common S&MA development language and format. IM also released the Safety Training Catalog (STC) application, which provides a training assessment via SSWP and the SHE Webpage. Safety, Health and Environment Tracking (SHEtrak) was modified to provide Environmental Management with a checkbox to use when closure is verified and to provide a chart of findings by category. The Safety Concerns Reporting System (SCRS) portion of SHEtrak was revised to provide a reassignment function for the reviewing Safety Representative and to incorporate improvements suggested by IS Representatives and through the MSFC Innovative Dynamic Employee's Active Solutions (IDEAS) system. SCRS processes were improved by requiring fewer steps to perform tasks, improving the layout, and appending reject comments to SCRS closure. Modifications were also made to the Certrak, Safety Bulletins, Space Flight Awareness, As-Built Configuration Status System (ABCSS) and S&MA Travel applications. The Audited Vendor List/Limited Vendor List/Project Specific Approved Supplier List applications were rewritten; release is pending owner review and approval. IM also developed the Safety and Mission Success (SMS) portion of the Management Actions Reporting System (MARS) application; deployment is waiting completion of other MARS modules. IM developed the capability for identified S&MA users to edit the personnel contact lists that appear for each S&MA organization on the S&MA web site. IM also developed a module that allows remote users to upload files through the web, enabling transfer of files to individuals in S&MA without using email. The upload functionality was developed in response to an on-going need for users to exchange large documents.

Information Management (IM) archived the IRMA application source code and database and requested deletion of the LAN seats, which will save S&MA over $1,600 per year. IM updated the Problem Reporting and Corrective Action (PRACA) security plan and performed a yearly review of user accounts with access privileges to S&MA applications, assuring compliance with provisions of NPR 2810, Security of Information Technology. Approximately 1100 IT Security Training completion dates were updated in the access control database. Numerous accounts and specific access privileges that were no longer needed were ended. In addition, user privileges for applications that had not been accessed in the past year were ended and user information, such as email addresses, were updated as necessary. IM updated the organization and personnel information in the SSWP application due to the recent center realignment. When the revised

organization data was incorporated, IM set up the new "reports to" data that provides for metrics reporting, set up user privileges for specific "suborganizations", and helped users with organization changes and new functionality. Information Management (IM) supported QD50 in the assessment of Dyadem RiskSafe 7 software to be used for IS Hazard Analyses. IM provided a preliminary template and report for review and comments to QD50. In addition, three IM personnel attended administrative training on Risksafe7 software. IM coordinated procurement of the training and coordination of facility preparation. IM also reviewed a draft SOP for the Information Technology (IT) Infrastructure and Systems Change Process and provided comments to the S&MA IT Manager and the Office of the Chief Information Officer. Comments provided included development of a process flow diagram for review and potential incorporation.

Additionally, IM supported S&MA in hosting Astronaut Donald Thomas' visit to the Center. The purpose of Dr. Thomas' visit was to present Silver Snoopy Awards and Team Awards to selected contractor employees.

4.5 Human Exploration and Development of Space (HEDS) Assurance

4.5.1 International Space Station (ISS) Independent Assurance

There was no significant activity during this reporting period.

4.5.2 Space Shuttle Independent Assurance

The final report of the Independent Assessment (IA) MH-4007, Procurement Quality Control of the United Space Alliance's (USA) Solid Rocket Booster (SRB) has been completed and is in internal review. The SRB Project has responded to the findings of this IA and these responses have been incorporated into the report. However, since the project has not yet responded to the observations of this IA, and in the interest of moving on, IA will make recommendations of the criticality of each of the observations and the recommended actions for the SRB S&MA team to present to the project when the report is formally transmitted to them.

Part of NASA Headquarters expectations for MSFC Independent Assessment (IA) is to support their newly instituted Program Analysis and Review (PA&R) process. Several months ago they began what they termed as Phase I with the Reusable Solid Rocket Motor (RSRM) project. MSFC IA was not able to be integrated into that activity. NASA headquarters has now begun Phase II of this activity and MSFC IA is involved. At this time, the involvement is both to review the ATK Thiokol documentation in preparation for on-site visits to ATK suppliers and to compile observations made at the on-site visit to Thiokol for the Phase II team review and discussion.

The Space Shuttle Main Engine (SSME) High Pressure Oxygen Turbopump (HPOTP) knife edge seal have shown some damage thought to be due to flutter. As a result, the SSME Program has conducted various tests to characterize the problem. There was enough data from these tests to affect a redesign of the knife edge seal. Currently, IA is participating in the Critical Design Review for this redesign.

During the launch of STS-114, the External Tank (ET) lost Thermal Protection System (TPS) Foam to an unexpected extent. Investigation teams were set up to determine the root cause (s) of the foam loss and potential ways to verify the integrity of the foam application prior to launch of the shuttle. The Independent Assessment Team (IAT) has been concerned that the Ice Frost Ramp (IFR) areas of the ET were not being properly addressed and took their position to upper-level S&MA management and, from there to the ET project. After more analysis and dissections of both test and flight hardware, the project has decided to at least modify some of the IFRs. IA is continuing to remain very involved in the process of redesign and of certification of the ET foam and the IFRs in particular.

4.6 Project Assurance

Project Assurance Engineering (PAE) performed activities in support of MSFC S&MA's efforts on Constellation Level II, including identifying contractor tasks, estimating levels of effort, assigning personnel, and supporting the weekly Constellation SR&QA Board meetings via video and voice telecons. Additionally, PAE planned and implemented HEI participation in the Initial Constellation Program Review (ICPR).

Project Assurance Engineering (PAE) performed various activities in support of S&MA efforts on the Launch Vehicle Integration, 1st Stage, Upper Stage, and Upper Stage Engine project teams. Activities included representing team support requirements to HEI functional managers to identify and assign Reliability, Quality, and System Safety engineers and coordinate their levels of support to the teams.

4.7 Risk Management and Risk Assessment

4.7.1 Continuous Risk Management (CRM)

During 2nd Quarter of Fiscal Year 2006 Continuous Risk Management (CRM) completed its support to QD40's CAIB/Diaz Action Digital Close-Out Photography (DCOP) Assessment Team from MSFC this quarter. The objective of this team was to help establish digital close-out photography requirements throughout the agency once all reviews and results had been presented to NASA HQ. The team was organized in order to bench-mark the many NASA/DoD contractor facility's (e.g. Lockheed-Martin in Sunnyvale, CA, Jet Propulsion Lab in Pasadena, CA, Boeing at KSC in FL and Raytheon in Andover, MA.). CRM had reviewed the NASA Programs/Projects current policies and capabilities associated with configuration control, closeout photographs, and engineering drawings and determined that the NASA Programs/Projects implemented policies, met the intent of the Columbia Accident Investigation Board (CAIB) recommendation. CRM also completed its review of the DCOP Team's recommendation for requirements that are to be included in the NPR 8730.x draft, NASA Quality Assurance Program Policy Document. In addition to the review CRM has since provided comments and signed off on the final/baseline version of the DCOP Final Report.

The S&MA/QD40 CRM team also supported this quarter's ST9 Solar Sail Project (SSP) in the development and preparation of the Risk Management Plan. The ST9 Solar Sail Risk Management Plan is compatible with Goddard Space Flight Center's risk management requirements and the New Millennium's risk management processes. The CRM Team has since

submitted its Draft of the ST9 Solar Sail RMP to the NASA/QD30, S&MA Lead for the ST9 Solar Sail Project.

The CRM Team presented a matrix review of all NASA risk requirements this quarter to identify what mandated CRM requirements are affiliated with the MSFC CRM Support Triangle: Facilitation, Assessment & Training. These requirements were identified and linked to the specific areas of the CRM charter to allow for a more precise & structured process of developing and implementing the CRM requirements of facilitation, assessment & training. These efforts are now conducted by the MSFC CRM Team. This Requirements Matrix Tracking Tool will be linked to the CRM website for access by all MSFC programs/projects. This matrix will aid program/projects in identifying what requirements are to be implemented in risk management plans and the project/program's CRM process. In addition, the CRM Team developed a projected Risk Management Maturity Model (RMMM) schedule capturing six MSFC Programs/Projects for assessments during CY2006. It also developed and prepared a CRM article for the MSFC Star to promote CRM throughout the center.

The CRM Team also conducted a review of all NASA HQ CRM requirements and linked them to the current CRM assessment process currently in progress. The requirements are from the following NASA directives: NPR 8000.4, NPR 7120.5 and Marshall Work Instruction (MWI) 7120.6. These documents form the triangle of support for conducting CRM at MSFC. All one hundred-twenty-two requirements have been linked to seven areas of interest of the Risk Management Maturity Model (RMMM) that are the key elements in the CRM Assessment Process. This process establishes the CRM requirement ruler and it ascertains a structured methodology for correctly incorporating CRM in all MSFC projects and programs by identifying the necessary CRM requirements to incorporate at what level and phase of the project or program.

The System Management Office requested a member of the QD40/CRM Team to be a member of the SVU NAR this period and to assess the SVU Risk Management effort. This portion of the SVU NAR Assessment concerns itself primarily with the Risk Management aspects of the SAP Version Update Project. The EVM support representative met with members of the SVU Project Team to discuss the Continuous Risk Management Process within the SVU Project and members of the SVU Project Team provided a demonstration of the SVU Risk Database (MDM) that the project uses to document SVU Project Risks. In addition, a detail review was conducted of the following documentation to support this next cycle of CRM assessments for CY 2006: SAP Version Update (SVU) Project Plan, Integrated Financial Management Program (IFMP) Program Plan, ASIPO Risk Management Plan (Final), Program Risk Management Framework, IFMP Project Quarterly Risk Review, Monthly Status Report (MSR) IEM SVU and SVU Schedules.

The S&MA/QD40 CRM Team provided CRM Training in-house to Cargo Launch Vehicle (CaLV) employees and contractors conducted this quarter. This Executive Overview CRM course re-familiarized the student with the fundamentals of CRM. It was given to project members who have had CRM training in the past but have not been active in its implementation. The areas of discussion focused on the following: (1) Risk Identification; (2) Analyzing Risks; (3) Plan; (4) Track; (5) Control; and (6) Communicate and Document Risks. The Active Risk

Management (ARM) database was also taught as part of an agreement with NASA's CLV Engineering Office. Additional combination classes of CRM/ARM will be taught in the future to accommodate the 600 support personnel that need this mandated training.

CRM attended the Cargo Launch Vehicle (CaLV) ASAP to review CaLV risk management documentation, processes and procedures. CaLV will be using the Active Risk Manager (ARM) database to document and communicate risks. CaLV will also be implementing a 5 x 5 Hazard Reporting Risk Assessment Code (RAC) to rank and score hazards. This process will allow safety risks identified through the Hazard Analysis (HA) process to be readily incorporated into the NASA standard Risk Assessment Code (RAC) which will reduce the need to for two matrixes and eliminate confusion as to what hazard belongs to what matrix when being reported as a program safety risk.

The CRM Team presented an overview of the capabilities and functions of the Orbital Space Plane (OSP) IRMA development risk database to the MSFC CIO and the Integrated Enterprise Management Project (IEMP) Risk Management Office to demonstrate the Integrated Risk Management Application (IRMA) to the IEMP as a preferred risk management database. This demonstration was also tied into the NASA HQ Office of Integrated Enterprise Management Program NASA HQ viewed the demonstration through a Web-X link. An overview of IRMA's current status was presented to include the current funding breakdown for server access and support software purchases. Currently, the Orbital Space Plane (OSP) version of IRMA is being readied for archiving. The development version of the database can still be accessed NASA projects interested in using IRMA as a risk management database can have access to "test drive". After the overview, the OSP development IRMA database was accessed and the presentation continued with, signing in using a user ID and password, familiarization of the menu box, risk data entry, generating a risk matrix, risk summary report, as well as generating a risk list. NASA HQ and the MSFC IEMP group were very impressed with IRMA and have asked for the following documentation: IRMA Users Guide, IRMA Administration Guide, and the IRMA Data Structure Reference. The CRM Team has promised to assist in any other IRMA related support as time permits.

The QD40 CRM Team initiated Phase I of the Risk Management Maturity Model assessment of the Orbital Express Project. The team met with the Orbital Express (OE) Project Manager (PM), to provide an RMMM Assessment in-brief. The PM was very enthusiastic about OE's implementation of CRM and welcomed our proposal of conducting an assessment. The PM also offered to provide a CD containing the necessary documents and reports. The OE assessment would not be able to participate in a typical risk review because the OE Project activities are on hold, awaiting the next shuttle flight to the ISS.

A NASA Agency-wide team is working on the update of NPR 8000.4, "Risk Management Procedural Requirements." As part of this effort, the CRM Team developed a survey to provide initial feedback on needed improvements in the document and the risk management process in general. The CRM Team completed the Risk Management Survey on-line and provided their inputs to the Office of Safety and Mission Assurance, NASA Headquarters. A follow-on telecom took place on March 8, 2006 to discuss the NPR 8000.4 re-write effort. The CRM Team

also developed a detailed review of NPR 8000.4 and prepared and submitted an in-depth list of comments for submittal to NASA Headquarters.

The MSFC PMC has approved the QD40/CRM Team to conduct a Risk Management Assessment for projects and programs located at MSFC using the Risk Management Maturity Model Assessment (RMMM). Phase I (risk management data gathering) of the RMMM Assessment for the Orbital Express (OE) Project was begun in February 2006. The OE project manager, NASA, was in-briefed about the RMMM process and provided the CRM Team with detailed documentation (Data Sources: OE Risk Management Plan, OE Monthly Status Reports, OE Schedules, etc.) to support the RMMM Assessment process. The CRM Team initiated the process of reviewing the source data on March 20, 2006.

The CRM Team was given the task of supporting the Constellation (Cx) Level II Document Development review/rewrite effort in coordination the Johnson Space Center Constellation Office. The Cx SR&QA Panel Documents review list will include: SR&QA Plan, Risk Management Plan, Integrated SR&QA Requirements, FMEA/CIL Requirements, Hazard Analysis Requirements, PRA Plan, PRACA Information System Development, PRACA System Requirements, Horizontal Integration, S&MA Requirements, Traceability, Pause and Learn (PAL) strategies, and Lessons Learned.

The CRM Team is actively involved in the Cx Risk Management Plan document development effort. Each member of the CRM Team is conducting a review of the Cx RMP and developing inputs/comments to be presented to the Cx RMP Document Lead (JSC). In addition, a member of the CRM Team is participating and supporting the weekly SR&QA Panel. There was an SR&QA Panel meeting conducted on March 23, 2006.

4.7.2 Space Shuttle Probabilistic Risk Analysis

Probabilistic Risk Assessment (PRA) was tasked with reviewing all pertinent Constellation Launch Vehicle (CLV) documents this quarter in preparation for the September SRR document review. PRA also held a document planning telecon with JSC S&MA and QD40 on writing the Level II Constellation PRA Plan and Methodology document. The team went over the documents required by Level II, as outlined in the recent Level II SMA presentation charts, and types of contents needed. The team also discussed the contents needed following the lessons learned. As a result plans were written for Shuttle PRA, OSP PRA and the previous Constellation PRA. MSFC is now responsible for assisting Cx Level II in preparing and reviewing 8 of the key Cx Documents. PRA is the primary support for this task led by S&MA QD01and has the responsibility for coordinating the Level II PRA Plan at MSFC. PRA coordinated meetings with the MSFC/HEI PRA team to review and discuss the preliminary draft of the SR&QA PRA Plan. An initial set of issues was compiled from attendees for presentation to the QD01 status briefing and PRA followed up this effort by presenting a status of the SR&QA PRA Plan to MSFC document team and QD01. Comments from PRA were compiled and sent to the PRA Plan document Lead at JSC. The document was distributed to QD10 team leads and the RBD Team for review/comments. These comments have since been collected and transmitted back to the document lead at JSC.

Probabilistic Risk Assessment (PRA) continued its support of the Post-ESAS Propulsion Architecture Study (PAS) this quarter as one of the reliability team members. PRA supports the twice-a-week telecons with the PAS team, and holds regular telecons with the other half of the reliability team, a contractor based out of GRC. PRA also participated in telecons with the reliability team lead at NASA HQ, and one of the ESAS analysts about the ESAS analysis approach and recommendations to the PAS reliability team. One recommendation was to update the CLV risk numbers to reflect the current configuration. This is being currently done by one of HEI's Risk Analysts, who also supports the PAS reliability team. PRA also discussed with the PAS and reliability team leads about the direction and analysis approach on how to analyze the various trade options. PRA was tasked by the reliability team lead to draft a short analysis plan and list of tasks and information needed to support the reliability assessment. PRA coordinated with the other team members and created a draft plans detailing the information and tasks required, and presented to the PAS at the regular telecon. The reliability team received some good feedback, and is in the process of updating the plan.

PRA was tasked this quarter with reviewing the SRB range safety and functional failure fault tree with SRB PRA analyst on modeling detail and common cause failure. It was decided to keep the range safety model modeled at the system level, and rearrange the functional common cause failures placement. PRA supported a discussion with JSC Shuttle PRA team members on regarding failure recording (PRACA) screening, methodological way of discounting failure and inspection data. PRA also supported the weekly Shuttle PRA status telecon with representatives from JSC, MSFC and MSFC prime contractors, submitted an updated draft charts for the SRB GN2 purge probe risk assessment to EV33 for review, reviewed and edited the draft Shuttle Abort models and submitted the remainder to the PRA analysts at JSC for review. PRA has begun recreating the shuttle propulsion elements functional failure generic priors using generic database and is also supporting QD40 in presenting the Iteration 2.1 Shuttle PRA results to the shuttle Propulsion Management Council Board.

PRA supported this quarter's telecons with Pratt & Whitney Rocketdyne (PWR) Canoga Park and MSFC SMA on the review of PWR's risk assessment of "SSME sensor failure probability due to liquid nitrogen dripping." The purpose of this risk assessment was due to evaluate the likelihood of sensor failure due to LN2 dripping that may lead to launch scrub or aborts or in-flight shutdown. By select and group sensors, allows one to establish a failure sequence logic diagram and review UCRs (Unsatisfactory Condition Report). With such in place the initial probability of a scrub or an in-flight shutdown can be calculated based on the UCR data and engineering judgment scores. The review of this PWR assessment lead to an action item to use "LN2 dripping" UCRs to check against the current SSME PRA benign shutdown UCR lists which would ensure completeness. PRA also led the SSME PRA TIM at Pratt and Whitney Rocketdyne (PWR) – Canoga Park, CA to discuss Iteration 3 SSME PRA efforts. The team was briefed by PWR's SSME Advanced Health Monitoring System (AHMS) reliability engineers and system engineers about the key improvements to SSME from AHMS. At the TIM, the team decided to use the current SSME PRA methodology and rediscount the applicable SSME failures that would benefit from AHMS. Furthermore, the AHMS Phase I FMEA has not been finalized. PRA will wait until the outcome of the upcoming AHMS Design Certification Review (DCR) to determine which past pump failures are valid for reassessment. From discussion with the engineers, it also appeared that the existing controller and vibration monitoring algorithm tests,

which have been active in the Stennis test stands since 1996, have indicated that inadvertent engine shutdown is low. PRA is in the process of verifying the data and results that were presented to the team. Finally, the team reviewed the updated SSME stuck throttle fault tree, discussed current Shuttle PRA schedule, and status.

PRA revised its Shuttle Abort PRA Event sequence diagrams this quarter for a number of abort options, namely, RTLS, TAL, ATO and stuck throttle. PRA also coordinated meetings to discuss ESDs and solicited comments from a number of JSC staff, compiled all comments into a file and prepared response to each comment. PRA estimates that additional effort will be required to resolve comments before actual modeling can begin. PRA is also in the process of collecting more information on the systems to be modeled as part of the Abort PRA.

PRA attended and supported two separate shuttle boards meetings this quarter with Space Shuttle Engineering and Integration Group (SSEIG); MSFC Propulsion System Engineering and Integration (PSEI) and the Chief Engineers Review Board) where Boeing presented the rationales for closing the "Integrated IFA STS-114-I-024 Closure of SRB GN2 Purge Probe Potential Liftoff Debris." The presentation included the result of a PRA on the purge probe lift-off debris impact risk assessment where PRA was the lead analyst, with supports from QD40, Boeing, USA and MSFC engineering (EV33).

PRA continues to obtain more information to complete the Event Sequence Diagrams (ESD) for the Launch Abort PRA, resolve/answer a number of comments and prepare a detailed schedule for the Launch Abort PRA tasks; the schedule is presently out for review. PRA also participated in gathering information to identify systems that are required for a successful abort of the Shuttle, such as working with JSC to identify all components that need to be modeled as part of the Power Pitch down.

PRA reviewed the SPRA Phenomenological Data Report and Appendices, and the Functional Data Report with several final corrections being made. PRA approved the SPRA Phenomenological Data Report and the Functional Data Report for publication and continued its efforts with reviewing PRACA reports for updating ET functional failures.

PRA conducted preliminary work this quarter to update the ET Thermal Protection System (TPS) model; which consisted of checking RTF design changes that will affect the PRA fault tree, evaluating FRAS applicability and data requirements, and finding available/potential data sources. PRA has also updated available PRACA data for input into the TPS FRAS spreadsheet but requires additional information on debond sizes. PRA performed preliminary distribution fits on available TPS debond data (volumes and masses), and determined that exponential and lognormal data gave good fits.

PRA reviewed this quarter's analysis of ET leaks to confirm assumptions regarding several basic events in the ET fire/explosion logic model. This effort was done at the request of SAIC/ JSC leads regarding the documentation of Iteration 2.1 analysis and was coordinated internally and with Lockheed Martin engineers who participated in the analysis.

PRA continued its work this quarter with QD40 on reviewing and editing the CLV launch abort system fault tree. Afterwards, PRA reviewed the past SRB and RSRM PRA models and located suitable risk numbers. For those events where no suitable PRA numbers can be located, an estimate calculation was performed using separate analysis and engineering judgment.

PRA drafted a white paper this quarter concerning uncertainty in PRA for use in CLV per request by QD40. PRA reviewed the paper with QD40 and incorporated their recommendation and suggestions. The next draft of the white paper is due to QD for comments by middle of next reporting period.

PRA and QD40 attended a meeting with MSFC Propulsion Systems Engineering, Integration Chief Engineer and MP71 on reviewing methodology for quantifying the risk of MPS contamination (possible titanium particle) to the engine. SPRA and QD40 provided a review of the initial approach and recommended uncertainty bounds to be added for the input parameters. As result of this meeting, SPRA was asked to take the uncertainty inputs provided by the group and perform uncertainty analysis using simulation software. The simulation was performed and will be presented to the integration group and SSME representatives in the upcoming week.

4.7.3 Shuttle Reliability Prediction and Risk Analysis

During the 2nd Quarter of Fiscal Year 2006 Risk Assessment (RA) was tasked with characterizing the ET's Third Hardpoint (THP) Closeout by using the Shearography Method. A portion of the ET tank foam is applied at KSC to cover an area left bare to enable handling. It had been proposed to use the nondestructive evaluation (NDE) method shearography to look for unbonded foam and other flaws in this region and in other regions. RA therefore provided a demonstration showing the benefits of taking data outside the range within which the detection limits should lie in order to best characterize the detection limit (breaking the process). RA also presented a more focused range of test scenarios to the team based on meeting specific test goals considering constraints to resources. RA participated in writing the overall long- and short-term goals for the team with rough test outlines and milestones for eventual NDE method certification. However no 'good' method for objectively measuring a response to flaws was developed by the time the test was run. In addition, the shearography appeared to have a response that gave clear indication of a flaw at very small flaw size, much lower than the critical dimension in this region. RA worked with the team to develop a test plan to assess approximate probability of detection (POD) in this region using simple pass-fail responses. RA developed and presented its plan to determine the binomial predicted probability of detection (POD) using a 7 successful detections of 7 distinct flaws criterion for each input factor level. This gave a 50% confidence on 90% detection probability.

SSME ultrasonic fastener stretch measurement equipment is being updated from relating Erdman counts to load to relating load to delta time. RA was asked to analyze the data for this testing. The main testing is being performed at Canoga Park and MSFC is performing a portion of the testing here to evaluate differences in location and to assure the accuracy of the readings at Canoga Park. New fixtures for the testing have been made and verification testing has begun. The location verification testing has begun with Canoga's portion of the part 1c testing being complete and MSFC being started on their portion of the part 1c testing. Data was also collected on Engine 0525, Engine 2059 and Engine 2058 with both the Erdman and Norbar machines. RA

compiled the databases and analyzed the results. Part 2a testing was begun at Canoga Park and RA compiled the data for these first two bolts. RA established curves to relate delta time of flight to load including error bands for each stack height/bolt combination and presented these preliminary curves to the team.

RA was tasked with analyzing the Flow Liner Crack Nondestructive Evaluation (NDE) Probability of Detection (POD) this period since cracks in flow liners could result in liberation of dangerous FOD upstream of the SSME's. RA is part of the team evaluating the "goodness", measured in terms of POD, of NDE methods in measuring these cracks. RA is rechecking and writing up final findings on the analysis of manufactured flaw data. New data is coming in from tests on simulated hardware containing realistic flaws. RA is assembled a database of this data as it became available and evaluated the partial dataset to address obvious anomalies and to look for initial patterns. The patterns that RA found in data gained through measurement on realistic hardware showing possible significant special causes affecting the measurement process that suggest inconsistencies in detection and mask POD were presented to the team. RA was assigned a task to see whether the inconsistencies corresponded to any interesting features in calibration data. So far, none has been found, but the study has suggested a way to monitor and assess family for that calibration data using statistical process control (SPC).

RA was tasked to assess the SSME Nozzle Cooling Tube Laser Braze Repair method testing this quarter. It is a new method of repairing damage in cooling tubes by using a very fine laser to replace a thin hydrogen-fueled flame. The new approach results in a smaller heat-affected area, among other advantages. RA suggested expanding the first matrix by including a variable that was clearly interesting: type of flaw being repaired. RA also supplied estimates of the power of the test, which indicates how likely the test is to find a change of a given magnitude. The second test was greatly improved by RA's suggestion to take the test to failure by over pressuring after pressure cycling instead of simply cycling without failure.

RA was tasked this quarter with critiquing the ET Inter-tank Volume Fill Material Shelf Life Study Results. Lockheed-Martin Manned Space Systems (LMMSS) performed work looking at whether there was performance degradation in material intended to fill cavities and thus prevent cryo-pumping from the inter-tank interior to voids in the exterior insulating foam. RA applauded LMMSS' efforts to bring a robust approach to both setting up test matrices and analyzing the resulting data. There were findings that effects were present in the data and were determined to be correct, but it was also determined that key mathematical methods used in the analysis could have been done differently. These would have shown larger effects and would have identified slightly different causes. Assertions that effects found using the mathematical analysis, even though statistically significant, were small in real terms, may have been correct, but were not presented using numerical comparisons of magnitude and were thus hard to assess. RA provided these comments to the project.

RA also assessed a large dataset from a series of 14 mockup IFRs was assessed for Independent Assessment (IA) and Materials and Processes (M&P) this quarter. It was found that the process used in the test was marginally predictable as far as being able to predict the number of large voids produced per structure. If one assumes predictability, one can infer approximately 4½ flaws $\geq$ 1" in the largest dimension, with an upper 95% confidence bound of 8 flaws. A study on

expected flaw size runs into the same problem as for the dissected tank structures analyzed earlier; this study is ongoing.

RA was asked to participate on the ET IFR Flight Imagery Assessment Team to perform statistical analysis on divot measurements recorded from ET flight imagery of LH2 IFR's. Best Estimate Mass numbers were generated by the team to try to capture divots > 1.5" viewed in each image as well as assessing Image quality. RA created distribution fits, reported summary statistics and performed means tests. RA also assessed divot rates across ramps and flights that accounted for the number of divots relative to the number of usable images. The preliminary analysis was used in conjunction with other teams' results to determine the status of ET 119 shipment from MAF to KSC and will also be used in updating future IFR risk assessments. RA has revised the charts several times as Best Estimate Mass numbers have been updated. RA has also added to the presentation with each revision as continued analysis is performed. Experts assessed loss mechanism for each measured divot. RA performed the analysis and prepared a presentation of the results. LO2 and IT estimated mass numbers were provided and RA prepared a presentation of the analysis. Flight image analysis of ET IFRs resulted in a useful database of locations, potential causes, and the like along with estimated sizes and masses of divots lost. Risk Assessment (RA) assisted in improving and presenting the statistical analyses showing that the proposed reduced-volume hydrogen tank IFRs can be expected to reduce risk due to divoting. Analysis was presented to the PRCB along with the recommendation that the reduced-volume ramps be adopted. Correct confidence bounds for the expected mean rate of divot production per ramp were computed and given to the probabilistic risk assessment (PRA) team. Analysis of the oxygen tank and intertank IFR foam loss imagery data was performed to outline the risk posed by these ramps. A sensitivity analysis looking at the effect of a range of assumptions on foam density was begun.

RA evaluated the "RMAT, Reliability and Maintainability, MAT, Training Manual for its usefulness in reliability work for the new crew launch vehicle (CLV) program this period. RA's main concern was to find failure rates for various components to be used. Two supporting references that were also studied: (a,)"Defining Support Requirements During Conceptual Design of Reusable Launch Vehicles", by Morris,W.D.,White,W.T.,and Ebling,C.E. of Langley (NASA) published by AIAA,1995; and (b) "Analysis of Shuttle Orbiter Reliability and Maintainability Data for Conceptual Studies", by Morris,W.D.,White,W.T.,and Ebling,C.E. of Langley (NASA) published by AIAA, 1996. These references indicated that the KSC PRACA database and a previously conducted Lockheed-Martin study could be used to find failure rates for similar items; research on this topic continues. RA was also asked to look at reliability predictions using both simulations and analytical methods. While each has advantages and disadvantages both require failure rates for the components involved. These failure rates, with their tolerances, are fundamental to reliability considerations. There is considerable data for electronic items but not much for mechanical items such as found in launch vehicles. With this in mind RA has been evaluating NPRD-95, Non-electronic Parts Reliability Data published by the Reliability Analysis Center for several mechanical items, actuators, synchros, transducers, etc. Looking only at airborne environments produces failure rates with tolerances that range from ± 230% to ± 80% for most items.

RA was tasked to perform a risk analysis on the frangible nut of the SRB. RA developed an equation giving velocity of the probe as a function of initial conditions and all appropriate variables. This serves as the fundamental relationship given velocity as function of time, height, etc; solve the problem in two ways, analytically and by simulation; propagate the uncertainty through two different methods, one by propagation of error math, and the other by random number generation (simulation method); gather available data for the independent variables with their tolerances; and plug in the values, determine the answers and do a comparison of them. RA is now supporting launch debris assessment by reviewing a test plan describing tests whereby spherical and cylindrical samples of Inconel and a particular plastic will be shot, at various velocities, into a steel plate to find the coefficient of restitution, COR. Other debris materials, rust, iron bolts, etc are also under consideration. The COR is used to calculate projectile velocities that could overtake and impact the Shuttle vehicle. A theoretical prediction of COR as a function of impact velocity, for a particular material pair, is being researched in order that the upcoming test data can be compared which has been difficult due the high velocities, 100 to 1000 ft/sec, involved. A combination of test results and theoretical predictions that offer reasonable agreement will be the best solution and allow COR usage with known error limits. Close attention to the accuracy of theory and experiment is necessary and is therefore the focus of RA.

4.7.4 Advance Projects Risk Assessment

During 2nd Quarter of Fiscal Year 2006 Risk Assessment (RA) continued its support to Advanced Projects (QD10) by performing a detailed but preliminary analysis of the LOM risk to the CLV in ascent. This included taking current STS Probabilistic Risk Assessment (PRA) values and adjusting them for operating time, performing a preliminary Space Shuttle Main Engine (SSME) air-start analysis, and using a 100,000 trial Latin Hypercube Sampling (LHS) Monte Carlo technique to produce uncertainty with good precision. The results from this analysis were then presented to the CLV Reliability, Maintainability, and Supportability (RMS) panel, and then were sent forward to the Level II integration team for further review as a baseline LOM requirement.

RA was also tasked to perform a detailed but preliminary analysis of the Space Shuttle Main Engine (SSME) air-start application for the CLV Upper Stage. This consisted of eliminating SSME start-up failures not applicable to an air-start application, finding a demonstrated reliability and scaling them to match the predicted reliability values of the current STS PRA. Further, the values were put through a SSME based reliability growth curve producing a table of risk values with uncertainty based on several "fix factors". The most conservative result from this was used in a baseline analysis for the CLV Loss of Mission (LOM) requirement.

RA was tasked to provide a detailed but preliminary analysis of the J-2X engine for use on the Upper Stage for the CLV. The physics of failure based analysis included an air-start risk estimate based upon J-2 historical data. Monte Carlo sampling on the uncertainty distributions of the assumptions was used to provide an uncertainty distribution for the overall risk.

RA created a draft process by which safety and reliability CLV level 2 requirements can be validated and verified. The main requirements looked at are the CLV Loss of Mission (LOM)

and Loss of Crew (LOC). These processes that will validate/verify these requirements are still being researched, reviewed, and disused under the Risk Based Design (RBD) related groups.

RA is determining the requirements language for LOM, presented a top level risk assessment in order to determine the appropriate language for the analysis-based LOM requirement. The LOM risk assessment study included a preliminary J-2X engine assessment and a 5-segment Solid Rocket Booster (SRB) assessment.

In support of CLV Integration this quarter RA performed a reliability assessment from historical databases on the probability of an inter stage related failure with only eight being found between 1953 and 2003. During this time period there were 2064 launches. This assessment resulted in a Binomial reliability prediction of 0.9937 at 0.90% confidents. RA was also tasked with providing a FMEA for the CLV launch abort system which is being populated with ROM reliability estimates. A more detailed FMEA which includes sub or component causes was constructed of the launch/ascent phase of the CLV. This is being refined with data sources with will trigger an abort being added. Additional support begun by RA is a failure simulation of a CLV launch/ascent failure that will model the debris, heat flux, and over pressure. This effort is designed to better understand the timing and g-load required for the CM to be able to escape safely from a vehicle failure at various stages of the liftoff and flight.

RA also performed a LAS abort reliability assessment in which a fault tree from close of hatch until Command Module (CM) stabilization was analyzed. With a predicted failure rate value of one in 367, the reliability values derived to populate the fault tree and the reliability numbers were rolled up to provide a preliminary assessment of the over all abort reliability. The fault tree was then modified to use a 12 Booster Separation Motors (BSM) approach. When mounting 12 BSMs around the periphery of the CM and no tower being used the overall failure rate for this approach was less reliable with a one in 279 failure rate predicted. These numbers are expected to change as the system becomes better defined. Many new trade-off studies and refinements will help with this definition. However additional work remains on substantiation and refinement of this analysis.

RA was requested this period to perform another trade study involving between 1 BSM and 12 BSM on the LAS system for use as additional velocity. Once the need for a boost abort has passed a LAS system can be used for CEV delta velocity. At present the CEV has used most of its weight budget already and so will come in over its weight limitation. Reducing the systems capability from six to four astronauts is currently being considered as an option. Some of this additional payload can be offset if the LAS system is fired to add additional velocity to the spacecraft. The question or concern is what impact(s) this would have on the over all vehicle reliability. Assuming the vehicle has an over all reliability/failure rate of one in 2000 (as dictated by NASA headquarters) this number would drop to about one in 913 and 573 respectively for the one and 12 BSM LAS approaches. These numbers are soft at this time and are expected to change with better system definition and more detailed analysis.

RA developed fault trees and reliability assessment modes for one, four and twelve motor abort systems this quarter. The single motor system was selected based mostly on its higher reliability. A trade study was also conducted based on the possible use of the Launch Abort System (LAS)

as a third stage to gain additional CLV payload however this option was finally dismissed because of reliability concerns.

RA supported this quarter's construction of the CLV FMEA. A set of suggested failure modes were developed completing the first two columns of the FMEA template from pre-launch through first stage burn out. Many examples were also developed to guide the engineers in completing the analysis.

RA obtained a generic CLV trajectory for use in developing a destruction debris model of the vehicle. The initial velocity (500 ft/sec) of the stage one fragments was calculated from simple bomb equations. The trajectory allowed a cursory assessment of LAS requirements for timing and acceleration in order to avoid the debris, heat wave, and over pressure.

RA supported the Stage One Reliability Trade Study and Model Building through its development of the functional Reliability Block Diagram (RBD). RA also developed an assessment comparing the reliability of the 4-segment versus 5-segment RSRM that contradicts a prediction of a 13% drop in reliability for the 5-segment. A physics based model of this is comparison is being planned for further evaluation.

RA supported efforts on constructing the Functional FMEA CLV First Stage FMEA. A skeleton of the SRB based on the block diagrams produced in 1998 for the STS SRB was constructed in the new format. The Functional FMEA has been submitted to the elements for completion and comment.

RA prepared and presented a presentation on how to design to reliability using RSRM examples to MSFC's S&MA Group, the modeling committee meeting as well as other interested groups. This presentation has also been scheduled for presentation at the next RBD meeting and also for an upcoming off site TIM.

5.0 COST REDUCTION ITEMS

Our continuing cross-utilization of employees, continuous analysis of work in progress to assure that application of resources meets the needs of the task, and the judicial acquisition and distribution of tools to enhance the efficiency of all team members allow us to minimize cost to the customer.